143
9-2-75

Dr-1572

ANCR-1241

ANCR-1241
UC-13

IDAHO NATIONAL ENGINEERING LABORATORY

GEOTHERMAL SPACE HEATING OF A GEOTHERMAL DRILLING RIG

J.G. Keller
L.G. Miller
G.L. Mines
A.S. Richardson

PREPARED FOR THE
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
IDAHO OPERATIONS OFFICE UNDER CONTRACT E (10-1)-1375

DATE PUBLISHED—JUNE 1975

MASTER

Aerojet Nuclear Company
IDAHO FALLS, IDAHO - 83401

DISTRIBUTION OF THIS DOCUMENT UNLIMITED

DISCLAIMER

Printed in the United States of America
Available from
National Technical Information Service
U. S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161
Price: Printed Copy $4.00; Microfiche $2.25

ANCR-1241

Nonnuclear Energy Sources and
Energy Conversion Devices
TID-4500

GEOTHERMAL SPACE HEATING OF
A GEOTHERMAL DRILLING RIG

J. G. Keller
L. G. Miller
G. L. Mines
A. S. Richardson

AEROJET NUCLEAR COMPANY

Date Published - June 1975

PREPARED FOR THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
IDAHO OPERATIONS OFFICE
UNDER CONTRACT NO. ~~AT~~ E(10-1)-1375

ABSTRACT

A geothermal space heating demonstration unit to establish the viability of geothermal water is described in this report. Heating of a drilling rig by geothermal hot water from a nearby artesian well has greatly reduced heating costs. The results of this report conclude that the saving of fossil fuels are approximately equivalent to that required to heat 80 average homes in Southern Idaho.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the contributions made in the installation and operation of the heating system described in this report. Principal among these individuals are:

J. D. Auten, F. Huckaby, and C. Mason; Reynolds Electrical and Engineering Company
E. G. Schlender; Raft River Electric Cooperative
R. R. Jones; Aerojet Nuclear Company

TABLE OF CONTENTS

1.0 INTRODUCTION AND SCOPE

Current utilization of geothermal energy for non-electric uses appears to be confined to expedient means of satisfying specific needs. To date, little systematic technical evalatuion and utilization investigations have been undertaken to find ways to maximize the use of this energy source.

The development of little used energy sources such as solar and geothermal has progressed slowly because of the relative abundance and cheapness of fossil fuel and other current energy sources. With the realization of the limited future supplies of conventional energy resources, the development of unconventional resources becomes critical.

Economic conditions, as they exist in modern times, lend credence to the proposition that Federal funding be used to support certain research and development activities in the development of geothermal energy. In order to generate sufficient interest and incentive for private enterprise to rise to the challenge and to participate in the development of geothermal resources as a viable energy system, it is deemed advisable for the Federal Government to construct and operate a variety of demonstration units. Cooperative effort between the Energy Research and Development Administration (ERDA) and other public or private concerns is anticipated for many of these demonstration units. Some demonstration units will be quite extensive whereas others will be of a rather small, but nevertheless important, nature.

The demonstration unit described in this report, although relatively small in nature, is a typical example of a new and novel approach to the saving of fossil fuel and development of geothermal energy through the utilization of an existing geothermal source.

In December 1974, drilling, in the Raft River Valley in Southern Idaho, of the first deep exploratory geothermal well was initiated by the Reynolds Electric and Engineering Company (REECo) under contract to ERDA. Figures 1 and 2 indicate the location of this well. Figure 3 shows the drilling rig. The climate of the Raft River Valley is typical of Southern Idaho with severe low temperatures in January as low as -27^{o}F. Drilling operations are normally carried out in the open or in semi-sheltered

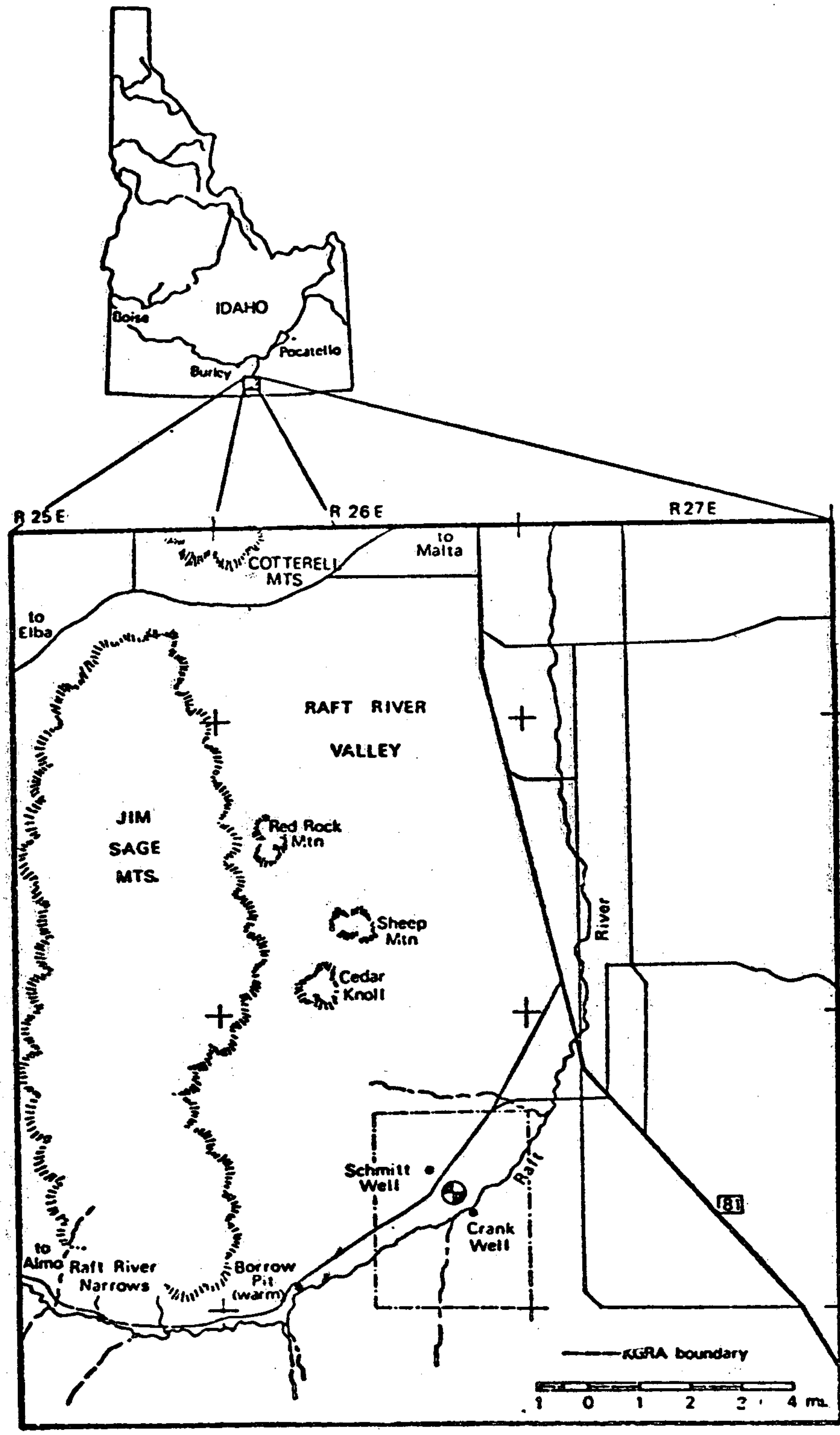


Fig. 1. Southern Raft River Valley and Frazier Known Geothermal Resource Area (drill site ⊕).

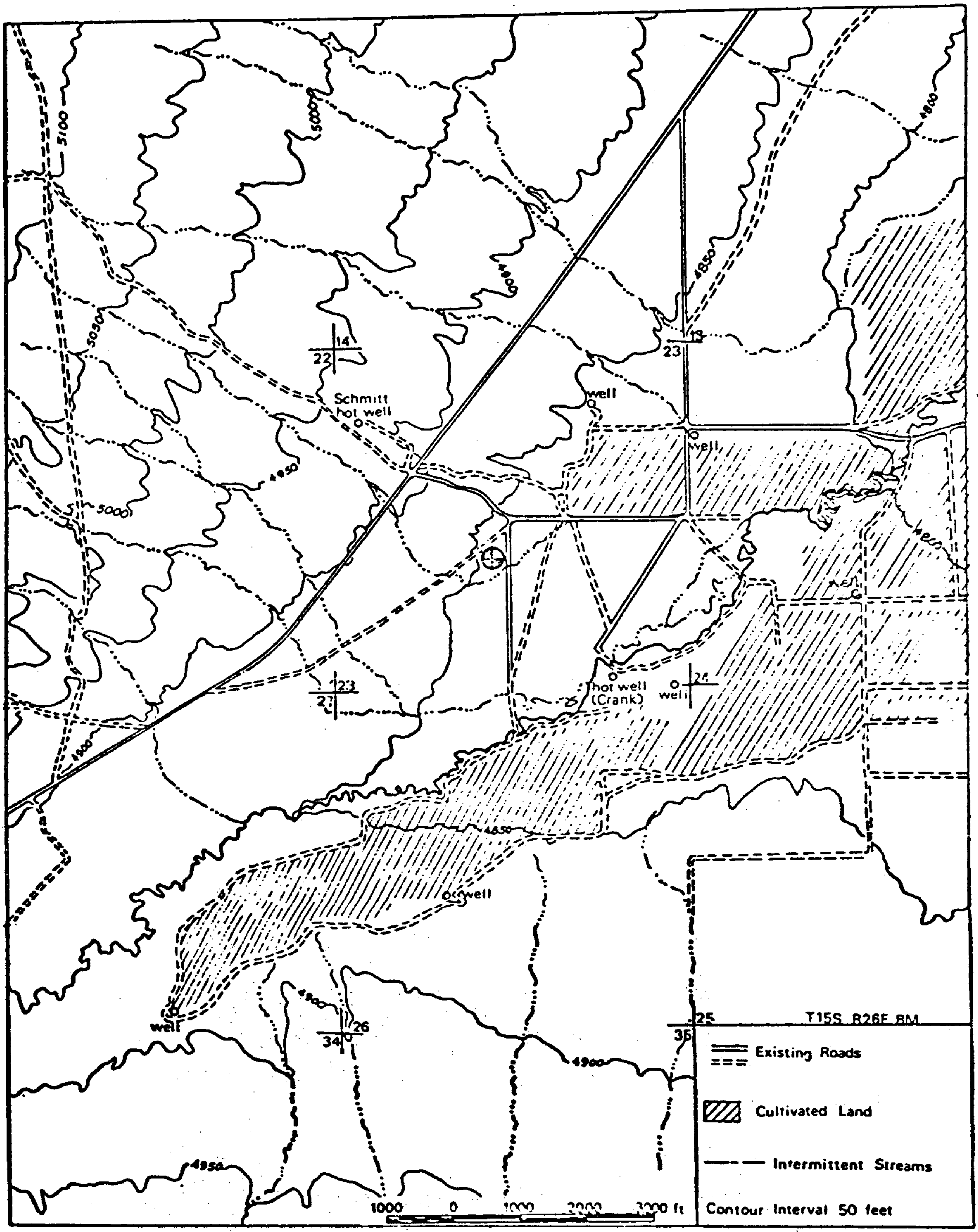


Fig. 2 Drill Site and Vicinity (encompasses most of the KGRA shown in Figure 1)

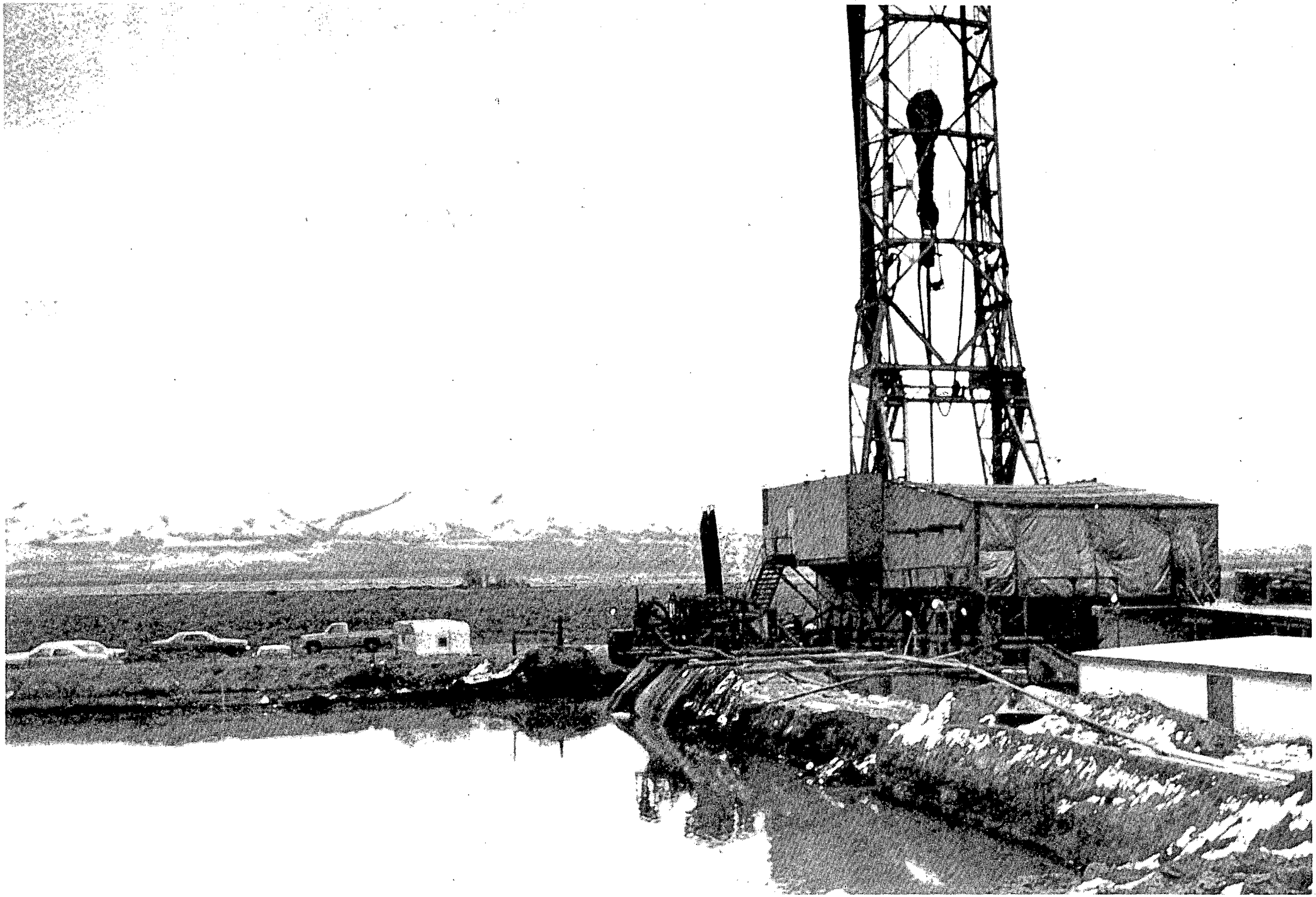


Figure 3   Drilling Rig

areas. To prevent extreme stiffness of greased working parts as well as to minimize personnel discomfort, drilling rig working platforms and cellars are normally heated with either electric space heaters or with fossil fuel generated hot water or steam space heaters.

An artesian geothermal well, drilled many years ago is located in near proximity of the site selected to drill the first deep exploratory well (Figure 4 Photo). It was decided to attempt to use the hot water from this artesian geothermal well to replace the normal fossil fuel heated hot water to temper the climate on and under the drilling rig. The following is a description of this well, often referred to as the Frazier hot spring or Schmidt well.

FRAZIER HOT SPRING AND WELL

> "There is a hot well in the NW¼NW¼sec.23,T.15S., R.26E, at an altitude of 4,930 feet at the foot of the range on the west side of the Raft River Valley. Before the well was drilled, there was a warm moist spot of ground at this place stained with spring deposits. C. W. Frazier, the owner, drilled a well 400 feet deep here and obtained a flow of about 120 gallons a minute with a reported temperature of 204^{o} F. The temperature of the water a few feet away from the well was found to be 196^{o} F. The well was drilled into alluvium, but its hot water may have ascended along a large fault that probably bounds the mountain range nearby. The well flows because of its high temperature and the included steam and is not necessarily indicative of the existence of an artesian basin. The high temperature of the water at the surface suggests that it is superheated not far below the bottom of the well. The water is used at present for irrigation."

This report described the layout and design of the heating system as well as an analysis of the operation and economics of the system.

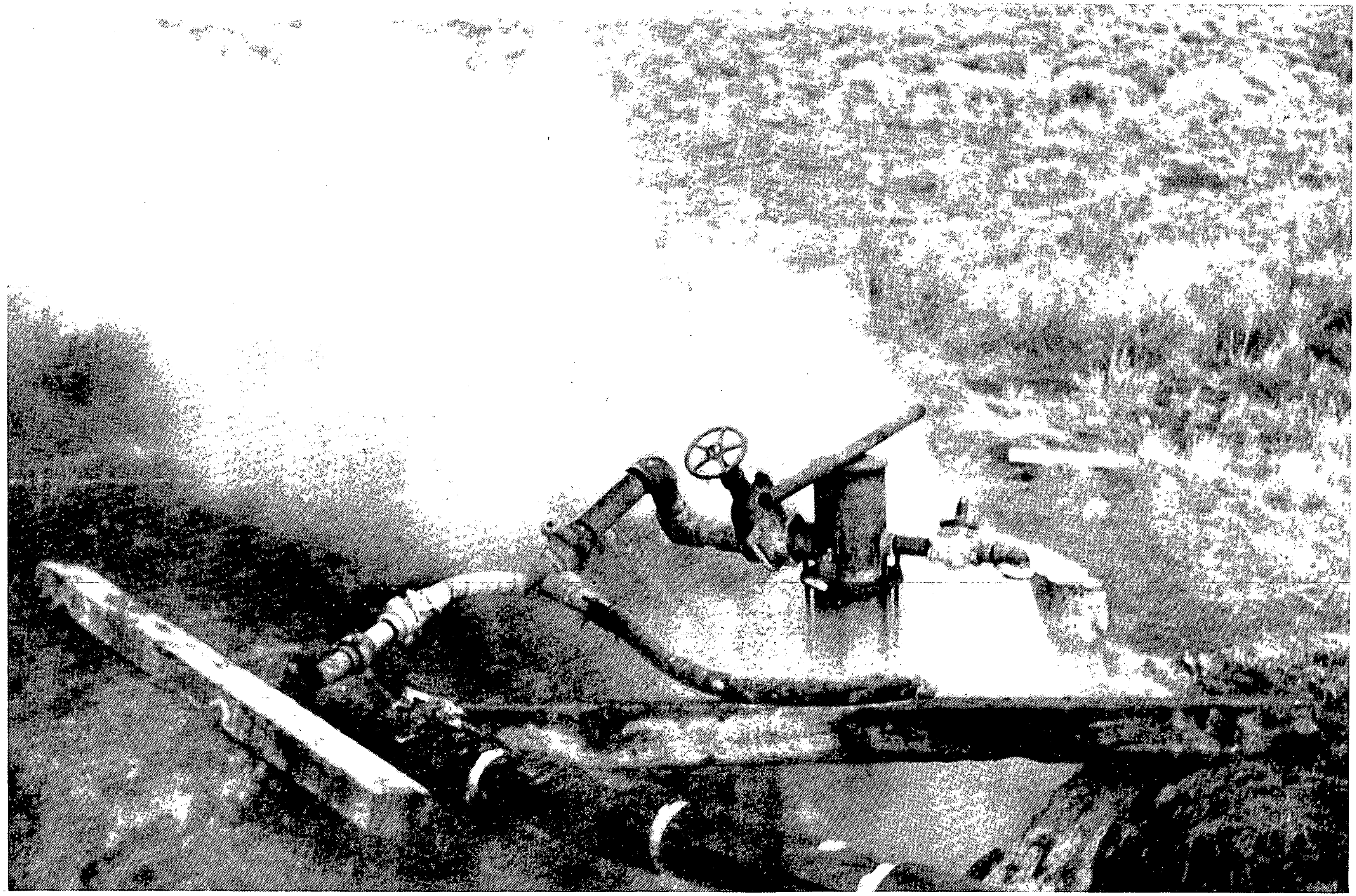


Figure 4 Artesian Geothermal Well

2.0 LAYOUT AND DESIGN OF SYSTEM

Figure 5 is an overall sketch which shows the general layout of the geothermal heating system as installed in and around the drilling site.

Geothermal water at a temperature of 199.4^{o}F flows from the cased well (shown in Figure 4) some 3,000 feet from the drill site. A small gasoline operated pump boosts this water through a fiberglass insulated, 2-7/8 inch, highdrill tubing to a small pumphouse located just west of the drill site (Figure 6, photo). The water is pumped from this point through four parallel heaters then through a water storage tank and discharged into the mud pits as a supply of makeup water or to reserve pit.

Geothermal water is used to maintain above freezing temperature of water in a large (about 21,000 gallon) water storage tank as well as to supply heat through four finned tube, fan driven, space heaters. Two of these heaters are located in the "cellar" under the drill rig operating floor and two located on the operating floor. The four finned tube space heaters were of unknown make but were essentially designed as shown on Figure 7. Figure 8 (photo) shows a photograph of one of these heaters.

The water storage tank heater is simply a 2-7/8 inch black iron pipe which passes through the lower portion of the end heads of this large horizontal vessel. The pipe is welded to the tank heads at both ends. This single pass system has been very effective in maintaining above freezing temperatures of the contents in this tank even though uninsulated. No inlet or outlet geothermal water temperatures could be obtained on this system.

The "cellar" area located beneath the drilling floor is essentially an enclosed area. No attempt is made to heat the entire area, but rather the heat from the convectors is mainly intended to moderate the temperature of the air and the equipment in the area around the drill system including the blowout protection gear.

The drilling floor is essentially open to the atmosphere, however, 8-foot high metal and canvas walls have been installed on all four sides of the platform. Although this area is open on the top, circulation of air within the enclosed area, by the fans on the convectors, minimized the mixing of colder atmospheric air with that heated geothermally.

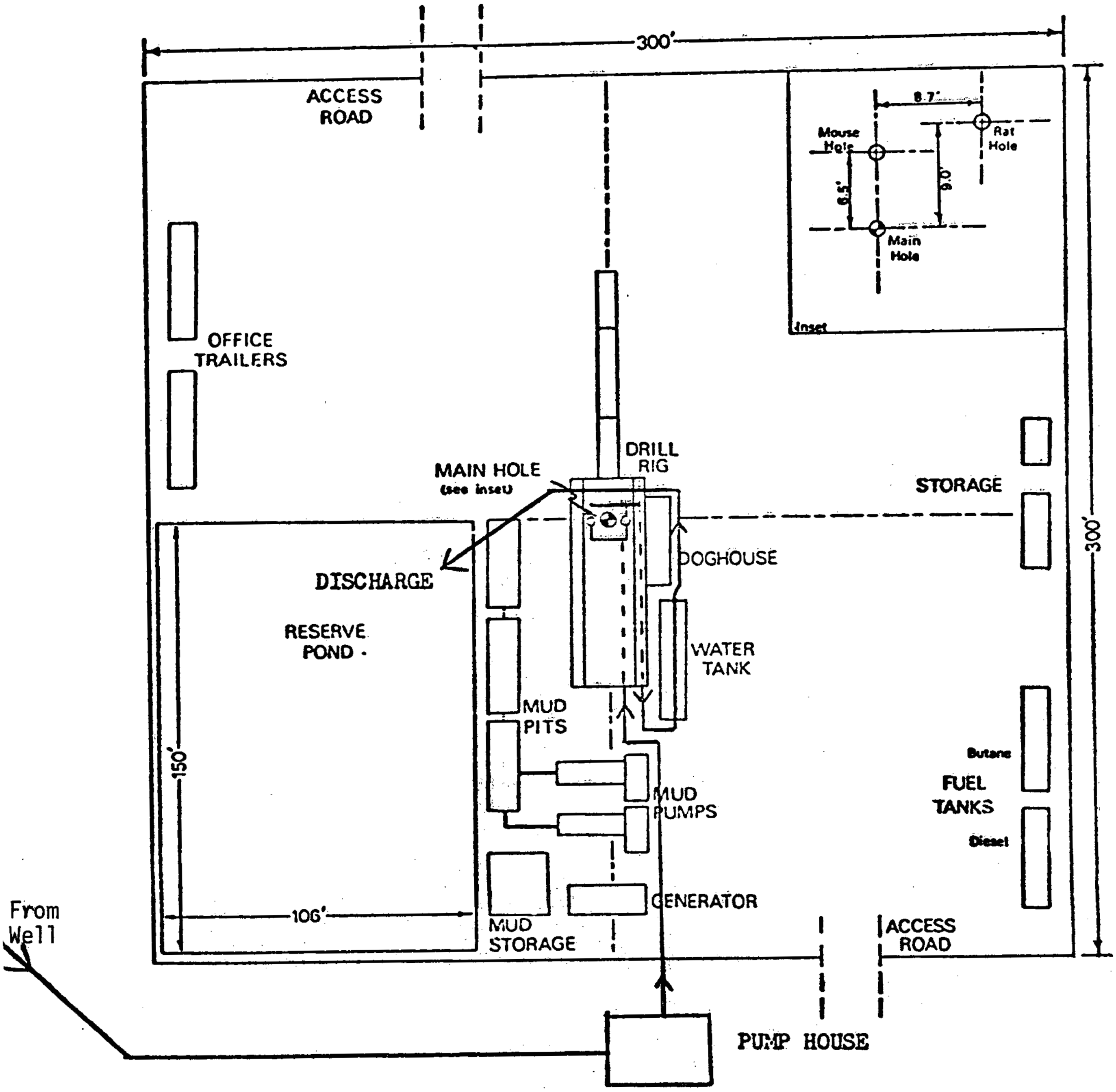
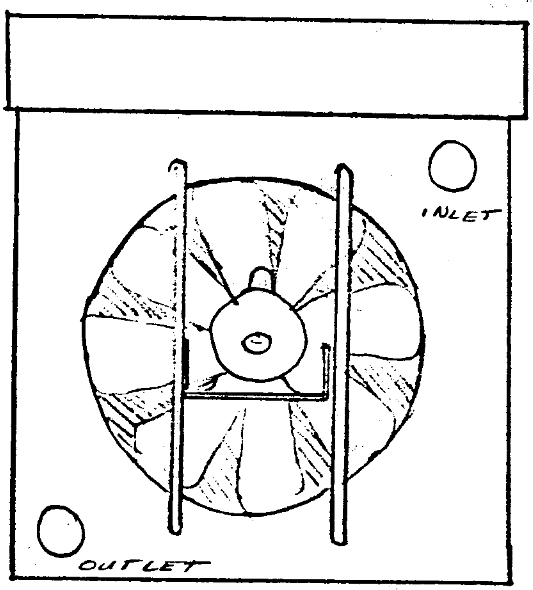


Fig. 5 General Layout of Geothermal Heating System

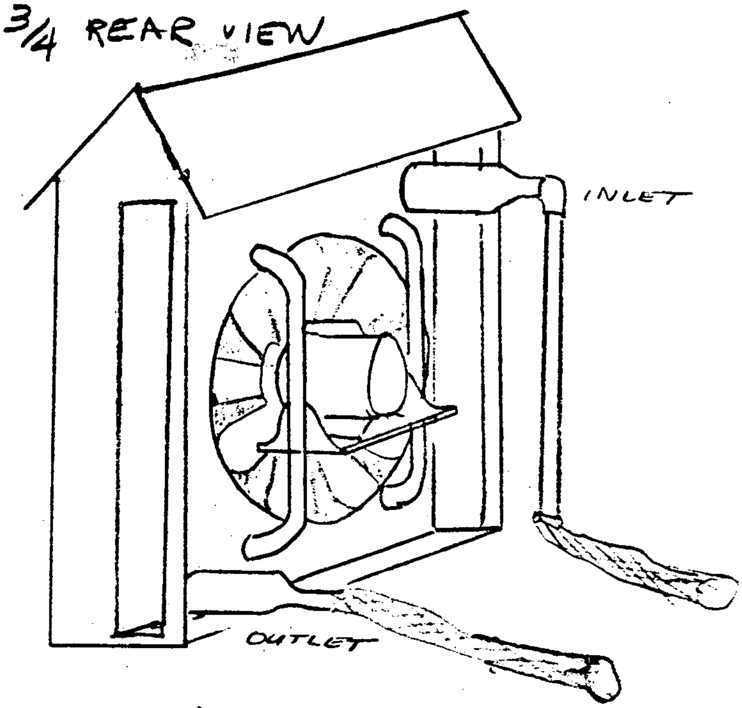
Figure 6 Pump House

FIGURE Drawings of space Heaters

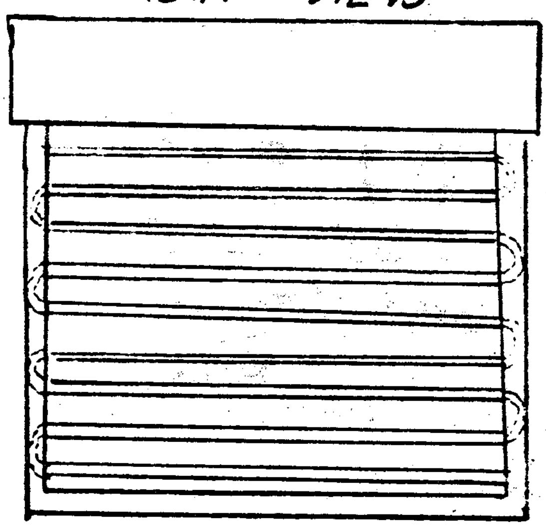
REAR VIEW

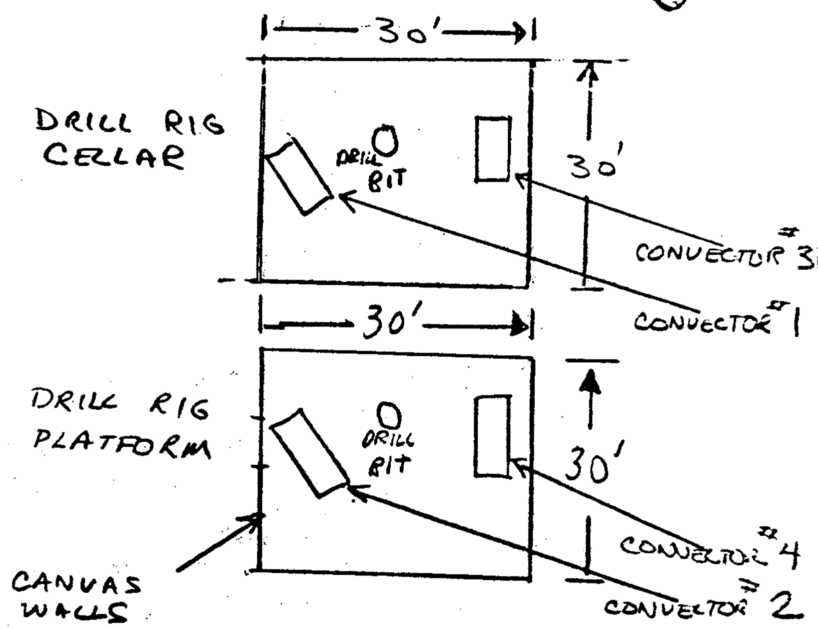


3/4 REAR VIEW



FRONT VIEW





3/4" dia. tubes (Al)
2" ℄ spacing of tubes

Louvres are also placed on the front over the air flow for heat direction

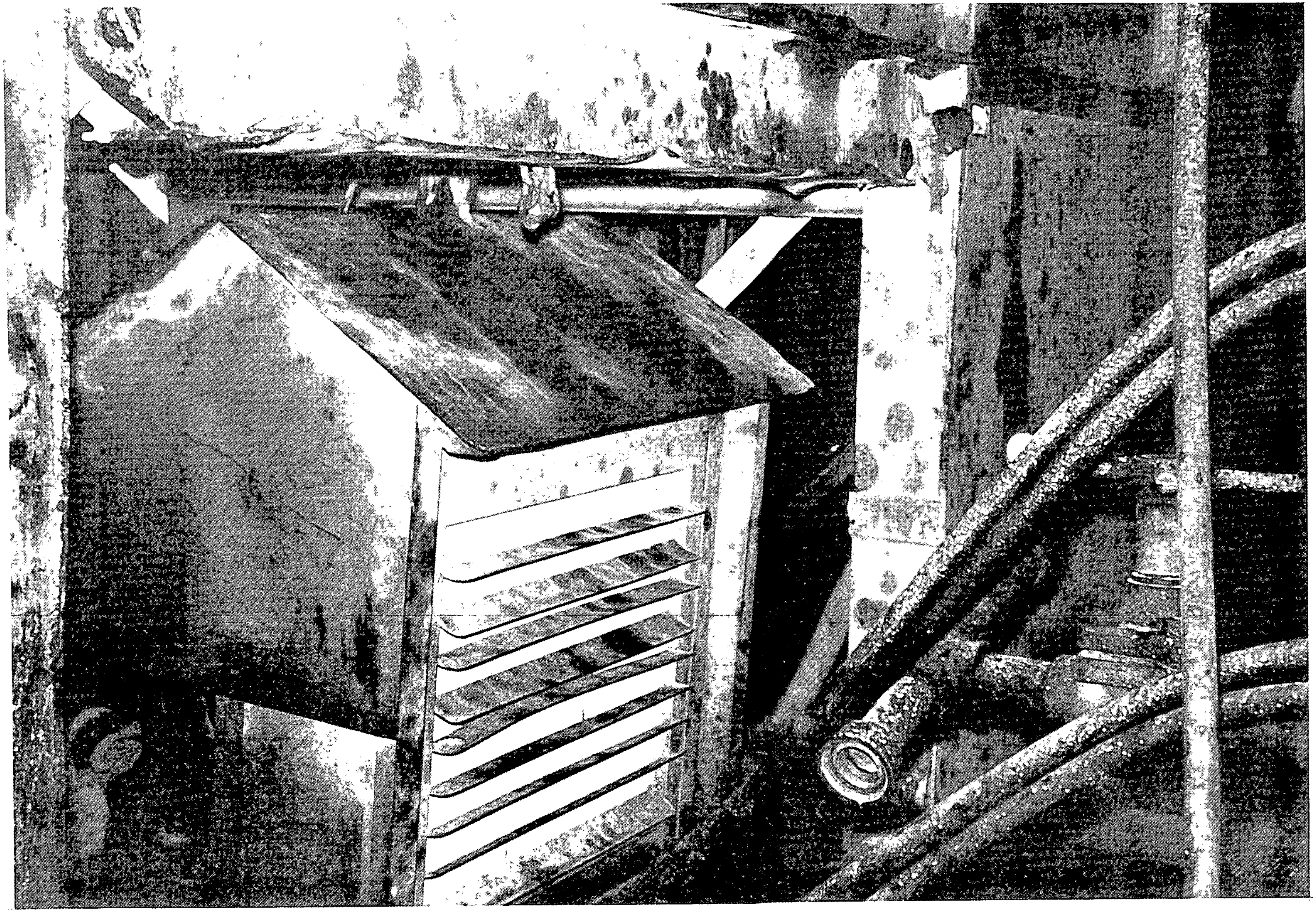
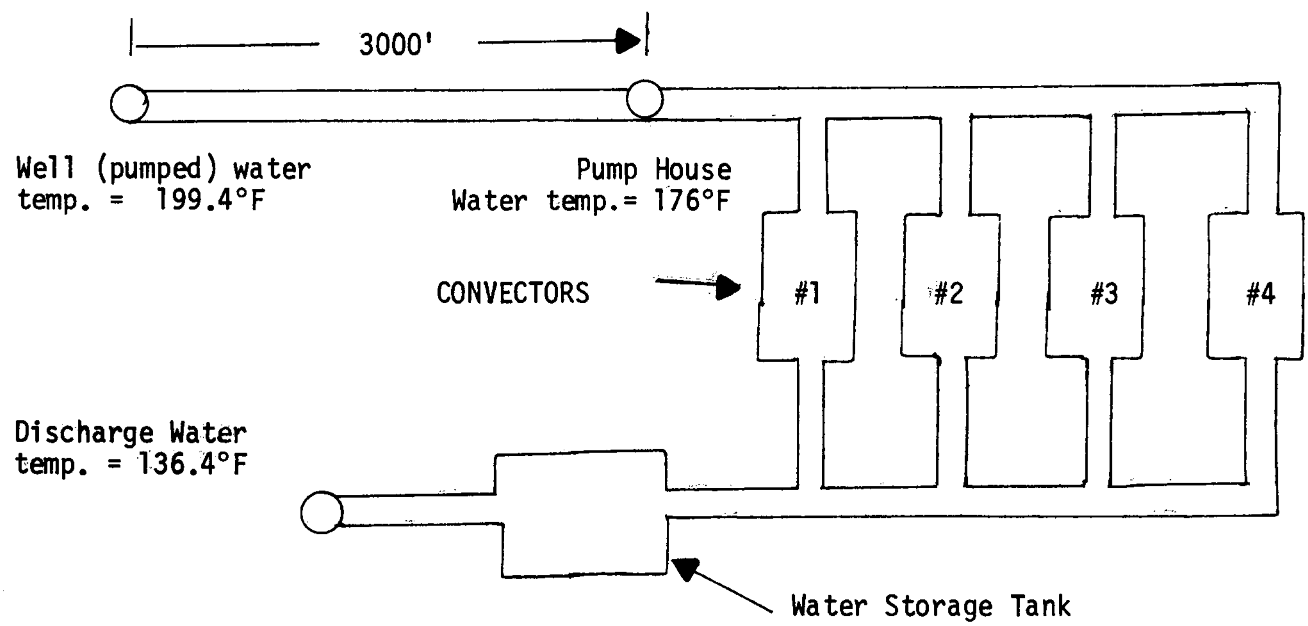


Figure 8 Space Heater

3.0 TECHNICAL DATA AND EVALUATION

Figures 5, 7 and 8 show the design and location of the hot water space heaters fed with geothermal water. Hot water is pumped from the geothermal well a distance of 3,000 feet through a 2-7/8 inch iron pipe to a small pump house (Figure 6) where the hot water is again pumped to circulate at 50 gpm through the heating system. Chemical analysis of the hot water appears in the appendix. The following diagram indicates the distribution system:



DISTRIBUTION SYSTEM

The geothermal water experiences a 23.4^{O}F temperature drop between the well head and the pump house ($\frac{.0078^{o}F}{ft}$). Loses are kept to a minimum by enclosing the transmission pipe with fiberglass building insulation tied every 10 ft. with fiber tape. At these loses, the geothermal water could be transmitted a total of 4.1 miles before losing its useful heat. Experiments will be undertaken to determine deposition when the drilling operation is completed.

The distribution system from the pumphouse through the convectors and water storage tank is a closed system and thus no measurements of water temperature or deposition could be determined. Although the convectors vary to a small degree in their physical characteristics, the flow of water is assumed to be equally divided between the convectors and then blended before being fed to the water storage tank heater.

Geothermal water flows to the convectors through a 2" water hose into 3/4-inch diameter finned tubes. A 3/4 - 1 HP electric motor drives a fan with 24" diameter blades to force air over the convectors. The following table gives data for 2 of the 4 convectors. Convector #1 was located in the "cellar" and Convector #2 was located on the operating floor.

	Convector #1	Convector #2
Air Temperature (inlet)	39.2°F	42.8°F
Air Temperature (outlet)	84.2°F	91.4°F
Air Temperature differential	45°F	48.6°F
Water Flow Rate (Estimate)	12.5 gpm	12.5 gpm
Effective Area of Convector	4.9 sq. ft.	5.3 sq. ft.
Air Flow Rate - Velocity	1,234 ft/min	1,267 ft/min
- Volume	6,046 cu ft/min	6,766 cu ft/min
Water Temperature (inlet)	Not taken	120.2°F
Water Temperature (outlet)	Not taken	102.2°F
(Note: The above were used to approximate water temp. drop and measured by pipe temp.)		
Estimated heat given off	3699 $\frac{Btu}{Min}$	4256 $\frac{Btu}{Min}$
Heat Available/Convector	14,785 $\frac{Btu}{Min}$	14,785 $\frac{Btu}{Min}$
Efficiency	25%	28%

The total heat available between water of the pump house (176°F) and the discharge (136.4°F) is 16,262 Btu/min which is distributed by:

1. Heat given off by convectors
2. Heat given off to water storage tank
3. Inefficiency of convectors
4. Conduction losses in distribution system

The total heat available per convector to ambient air temperature on the date the measurements were taken was 14,785 Btu/min. Thus, the efficiency listed in the above table represents the ability of a specific convector to remove all of the available heat. These efficiencies are in fact somewhat low since the calculations did not include heat given off to the water storage tank.

The drilling rig normally employs a hot water boiler system with a capability of 70 boiler horsepower. Calculations involving a boiler system with similar temperature conditions and flow rates gives an estimated saving of 15-20 gallons of fuel oil an hour. At an average rate of 35¢ per gallon for fuel oil, this results in a savings of $3,780 - 5,040/month, or the equivalent of heating 80 average homes for one month.

It must be noted that the efficiencies and evaluations made on the geothermally fed space heaters were done on a single day analysis. Although these values may change with daily climatic conditions, the capacity of the space heaters fed by geothermal water to maintain an above freezing temperature, should remain consistant. Therefore, estimates on the fuel savings approximate a realized potential to maximize the uses to which geothermal energy can be applied.

4.0 CONCLUSION

Although the preceeding example of one geothermal application seems small at best, the saving of approximately $4,000/month and the corresponding conservation of depleting fossil fuels tend to enhance its relative importance. The Reynolds Electric and Engineering Co. (REECo) will soon be drilling a second well for the reinjection of the production well water. At that time, evaluation of deposition will be conducted, and the heating system reassembled at the new site. Further examination will be undertaken to maximize the utilization of geothermal water.

SELECTED REFERENCES

1. Geothermal Investigations in Idaho Part I, Idaho Department of Water Administration, Water Information Bulletin No. 30, May 1973, p. 36.

2. Geology and Ground-Water Resources of the Snake River Plain in Southeastern Idaho, Geological Survey Water Supply Paper 774, 1936, p. 170.

3. Environmental Report Deep Geothermal Test Wells in the RAFT River Valley, S. G. Spencer, Feb. 1975. ANCR-1204

TABLE I

Chemical Analyses of Hot Wells in Raft River Valley

(Chemical Constituents in Milligrams per Liter)

	Schmitt*
Reported Well Depth (ft.)	414
Discharge (gpm)-reported, and variable	58
Temperature (^oC)	93
Silica	90
Calcium	53
Magnesium	0.4
Sodium	560
Potassium	22
Bicarbonate	55
Carbonate	0
Sulfate	57
Phosphate	0
Chloride	900
Fluoride	5.7
Nitrate	0.54
Dissolved Solids (Calculated)	1,720
Dissolved Solids (tons per acre-ft)	2.34
Hardness (as $CaCO_3$)	130
Hardness (non-carbonate)	89
Specific Conductance	3,050
pH (field)	7.4
Alkalinity (as $CaCO_3$)	45
Percent Sodium	88
Sodium Absorption Ration	21

*Schmitt or Frazier Hot Well are common names given to the geothermal artesian well

Table II

Chemical Analyses of Hot Wells - Specific Elements
(in ppm except as indicated)

	Schmitt
Mercury (ppb)	<0.1
Silver	<0.02
Gold	<0.01
Cadmium	<0.01
Cobalt	<0.05
Copper	0.02
Nickel	<0.05
Lead	<0.06
Zinc	0.02
Arsenic	0.003
Antimony	<0.2
Iron	<0.02
Manganese	0.02
Strontium	1.4

DISTRIBUTION RECORD FOR ANCR-1241

External

143 - UC-13 - TID-4500, R62 - Nonnuclear Energy Sources and Energy Conversion Devices

Internal

1 - Chicago Patent Group - ERDA
9800 South Cass Avenue
Argonne, Illinois 60439

3 - A. T. Morphew - Classification and Technical Information Officer
ERDA-ID
Idaho Falls, Idaho 83401

31 - INEL Technical Library

20 - Author

Total Copies Printed - 198